GE Aircraft Engines
Flight Safety Office
Sarah Knife,
Senior Staff Engineer – Industry & Regulatory affairs
General Electric Company
One Neumann Way Cincinnati Ohio 45215
Mail Drop J60
Phone (513) 243 3032
Fax (513) 243 0164

Subject: CAAWG Task Completion

Date: August 24th 2001

to: C Bolt

Dear Craig

I am happy to report that the Continued Airworthiness Assessment Working Group has completed the task of dispositioning the comments to draft AC39-XX. Consensus was reached on all points. I enclose a final status report and also our Task Group report, to be forwarded to TAEIG for their consideration.

I would request TAEIG, at their next meeting, to approve this report and forward it to the FAA.

Regards, Sarah

S Knife, PhD
CAAWG Chair

Handout 5

CAAWG Disposition of Public Comments to Draft AC 39-XX

Background

The Continued Airworthiness Assessment Working Group was tasked in December 2000 by the FAA, through ARAC, with the following:

> Reviewing the comments received to the Notice of Availability of proposed Advisory Circular AC 39.XX.
>
> Providing recommendations and advice on the task.
>
> Dispositioning comments considered inappropriate for incorporation into the AC.
>
> Making recommendations for revised language, in paragraph form, to address those comments with merit.

The following material completes this task.

General comments

GENERAL COMMENT 1

Several commenters indicate that the intended audience for this AC is not clear, as follows:

> "Who is this Advisory Circular aimed at, the ACO or Manufacturer/TC Holder (Applicant)? Typically, AC's are targeted to the applicant to aid in their demonstration of compliance to the regulations. Guidance to FAA is typically contained within policy or orders. This AC appears to be aimed at the FAA certification engineers, not at TC holders attempting to develop an acceptable continued airworthiness program with the FAA. Recommend developing guidance that is "party neutral"
>
> "Paragraph (b) states that the goal of this AC is to harmonize the continued airworthiness assessment policy between the two Directorates. However, the document itself seems to be intended for the whole aviation community . We believe the goals of the AC need to be defined with more clarity."
>
> "It is not clear what aspects of the process will be done by the regulatory authority and what will be done by the manufacturer"

The Working Group agrees that this rule and AC is unusual, since it does not involve an applicant requesting a finding of compliance from the FAA. The rule simply describes action which the FAA may take, and the AC gives guidance on the circumstances where this action would be appropriate. The AC is likely to be used by the type certificate holder, for instance in developing control programs to be proposed to the FAA, and by the FAA in the assessment of such control programs. Therefore guidance should be provided which is appropriate to the FAA as well as to the TC holder. The Working Group recommends clarifying wording be incorporated into the AC "Purpose" as follows:

Note that the descriptive level of the CAAM process contained in this AC is aimed at the individual, whether from the FAA or the manufacturer, who is without extensive risk analysis experience. Some of the material within this AC will therefore seem very basic to the experienced analyst. Additionally, this AC recognizes that an analysis must sometimes be performed without the benefit of readily-available information from the manufacturer. Typically, it is expected that more specific information will be available to the analyst, thus eliminating the need for some of the process steps which are described.

While information may be provided by and the assessment performed by the applicant, decisions as to whether an unsafe condition exists, and the appropriate responses to that unsafe condition, are exclusively the responsibility of the Administrator.

GENERAL COMMENT 2

Many commenters express concern over the separate guidance given for the E&PD and the TAD in appendices 4 and 5. It is strongly felt by the commenters that separate processes would lead to conflict between Directorates and that the processes would not result in the same standards of safety. A representative sample of comments is given; listing each comment would be unduly voluminous.

> "The proposed AC ...suggests that the risk to passenger analysis will be used on Part 25 issues and the CAAM principles will continue to be used for Part 33 issues. However, there is no clear language to how conflicts between the two approaches will be resolved"
>
> "There is some confusion regarding the applicability of the two different methodologies for corrective actions carried out by or for the TAD or E&PD. It is clear that for conditions associated with installation items not part of an engine or propeller type design, that TAD guidance would apply. However, it is not clear whether, for items that are part of the engine or propeller design, E&PD guidance would apply to the item as certificated or whether TAD guidance would apply to the item as installed. To prevent confusion and possibly unnecessary duplication of work, additional clarification is requested."
>
> "The importance of the question between competing requirements between the TAD and E&PD cannot be understated. In the event of disagreement between the two Directorates, which Directorate has the final authority?"
>
> "There is also an important question regarding if actions are being performed under the two Directorates are in fact being performed to an equal standard. There is an appearance that the requirements of the E&PD are more severe but also more objective and uniform ...."
>
> "It appears there is some potential for conflict between Directorates since appendices 4 and 5 prescribe different processes for the two Directorates. The two processes do not appear to result in the same levels of conservatism. The process for conflict resolution should be clarified."
>
> "As presented in the proposal two risk analyses (injury to passenger and CAAM) will need to be performed on Part 33 issues. It is recommended that this approach be removed from the proposed AC and CAAM-like approach be consistently be adopted for Part 33 and Part 25 issues."
>
> "the responsibilities of the FAA-Directorates need to be clearly defined"

The Working Group agrees that the AC should not have separate guidance for TAD and E&PD. The Working Group has developed an approach which will enable both Directorates to use the same guidance. This approach, and the rationale for the approach are given in attachment 1 to this report.

The Working Group has received instruction that wording on inter-Directorate coordination is not appropriate for inclusion in the AC. However, the Working Group strongly urges the FAA to pursue a robust process for coordination between Directorates on policy and continued airworthiness issues.

GENERAL COMMENT 3

Several commenters and Working Group members express concern over the difference in philosophy between Directorates when establishing safety standards.

> "A probable outcome of managing an unsafe condition to a single injury is to skew the overall level of safety for different size airplanes. In our opinion, this would not be an acceptable situation."
>
> "The risk to passenger methodology as presented is dependent on aircraft size (passenger capacity), configuration (wing or fuselage mounted powerplants) or application (passenger or cargo) It could be extrapolated that there could be multiple risk to passenger management plans required for an unsafe condition and that different aircraft sizes could be held to widely different safety standards."

It appears from Working Group discussions that TAD is attempting to minimize the number of persons injured in accidents each year, whereas E&PD is attempting to minimize the number of accidents involving injuries. This produces significant differences in approach for the largest and smallest airplanes. Both Directorates believe that their approach is sanctioned by Executive Order 12866, stating " *in choosing among alternative regulatory approaches, agencies should select those approaches that* ***maximize net benefits (including*** *potential economic, environmental,* ***public health and safety****...)"*

The difference in goals makes it difficult to reach consensus when producing a common process to be used by both Directorates. The difference in philosophies between Directorates lies outside the scope of this task, but the Working Group recommends that the FAA develop a common approach on defining "safety".

GENERAL COMMENT 4

One commenter states that the sequence and flow of the document is extremely confusing, and recommended redrafting to streamline it.

The Working Group agrees that the document layout is confusing, especially the numbering sequence of sub-paragraphs. It is almost impossible to determine the correct identification for a sub-sub-paragraph. Moreover, the numbering system provides no means to distinguish between paragraphs appearing in the introductory material (above the signature block) and paragraphs appearing in the body of the AC (below the signature block), since paragraph numbers are duplicated in these separate areas. The Working Group proposes that, at a minimum, all sub-paragraphs be identified at their beginning by the full number – such as 2,5,d, 2, rather than the current practice of simply denoting the subparagraph as 2 and leaving the reader to determine how the sub-paragraph fits into the document. Paragraph numbers assigned above and below the signature block should be different. The Working Group also recommends that the FAA acquire the technological infrastructure and resources to translate the FARs, associated advisory material and interpretation, into linked html documents. Appropriate use of hotlinks will then greatly facilitate document organization and promote accessibility and comprehension by the reader.

GENERAL COMMENT 5

One commenter points out that valuable information appearing in the Federal Register Notice of Availability, regarding the fact that the FAA is not obligated to use this methodology or to accept manufacturers analyses performed in accordance with this AC, does not appear in the AC. The commenter asks that these statements of intent be added to the AC itself.

The Working Group agrees. The Working Group proposes that the following wording be added to section 1 (Purpose):

> "*This proposed AC does not establish any requirement that the FAA must perform a risk assessment before issuing an AD, or that the FAA must wait to issue an AD until the design approval holder performs a risk assessment, or that the FAA must accept the findings of a risk assessment performed by the design approval holder. CAAM, as described in this proposed AC, assists the FAA in making decisions concerning the priority in which unsafe conditions should be addressed. The FAA may issue an AD for a particular unsafe condition before a risk assessment is performed, or without having an assessment performed at all.*".

GENERAL COMMENT 6

A number of comments advocate that the AC should be harmonized and that the scope of the AC should be expanded from propulsion systems to cover the whole airplane, or to cover multiple categories of aircraft.

The Working Group desires early publication of advisory material relating to propulsion systems and therefore supports a phased approach to developing advisory material of broader applicability. The Working Group is not tasked with harmonization and is tasked only to address Transport Category propulsion installations. The Working Group agrees that the next goal should be a harmonized, transport airplane-wide process, followed by development of a process applicable to multiple categories of aircraft. In order to provide a way forward to those objectives, the working group recommends that, upon completion of this task group's disposition of public comments to the draft AC, the FAA task ARAC with a project to develop an expanded, harmonized version of the current AC applicable to overall airplane continued airworthiness (airframe, systems, engines, propellers, appliances, parts, etc.) The Working Group is willing to accept the finalization and publication of the current AC with its limited applicability as a first step in completing an AC applicable to transport category airplanes with a target for completion of the broader harmonized AC as soon as possible.

GENERAL COMMENT 7

One commenter expresses concern that the AC process can not be used by other sectors of the industry, such as rotorcraft, since numerical data is not available to them on fleet exposure etc.

> "We have concerns that the FAA will use this same AD process on the General Aviation and Rotorcraft portion of the aviation industry.. Although the proposed AC 39-XX is noted as being applicable to Transport Category Airplanes, the FAA has in the past forced some of the same processes for Part 25 onto parts 23,27 and 29 aircraft. As an example, 25.1309 is being required on some rotorcraft certification.
>
> The processes being proposed are all based on having failure and exposure data available for analyses and decision making. These failure data relative to sections 21.3 are available for General Aviation and Rotorcraft, however, exposure data of flight hours, number of flights and number of passengers are not required to be reported on aircraft

operations other than those operations under part 121. These exposure data do not exist for the fleets of General Aviation and rotorcraft Aircraft since they do not operate under Part 121. The proposed AD process that requires determination of existing risk and predicted risk cannot be achieved for the General Aviation and Rotorcraft fleets without that data. Even the qualitative process described in the proposed AC 39XX is still based on the number of people at risk (data which is still lacking) if no AD is issued."

The Working Group agrees that this process would not be appropriate to rotorcraft or general aviation. The Rotorcraft Directorate uses other, existing methods to assess airworthiness. It is not intended that this AC be used for part 23, 27, or 29. Since the AC title specifically refers to Transport Category Airplanes, no change is recommended to the AC in response to this comment.

GENERAL COMMENT 8

One commenter requests that the FAA request ARAC undertake a project to further develop the AC and to disposition comments.

This task has been undertaken and completed by the Working Group.

Comments to Material above the Signature

COMMENTS TO 2. **RELATED REGULATIONS (CFR) AND READING MATERIAL.**

One commenter suggests that the basic certification/qualification requirements for aircraft, aircraft engines, propellers and appliances need to be listed as these are the basic Airworthiness Standards for the aeronautical products covered by FAR Part 39.

The Working Group does not agree. Referencing the basic Airworthiness standards as a group is not normal custom and practice, as they are assumed to be common knowledge. Furthermore the referenced regulations are those directly applicable to the AC.

One commenter questioned some of the references mentioned in "related reading material". This comment was subsequently withdrawn by the cognizant Working Group member.

COMMENT TO 3. **APPLICABILITY.**

Two commenters express concern that threats to persons outside the aircraft were to be considered. They point out that the environment outside the aircraft is impossible for the manufacturer to control and that mitigation of threats to persons outside the aircraft is in many cases impracticable. They also point out that the current Airworthiness Standards are silent on this point, and expressed concern that the continued airworthiness guidance should not hold products to a higher standard than that intended by initial certification.

The Working Group agrees that it may be impractical to mitigate certain threats to persons outside the aircraft. However, the Working Group notes that the scope of part 39 is not limited to conditions regulated by part 25. The Working Group is also aware of FAR 25 having been applied to certain hazards to persons outside the aircraft in the past. The Working Group recommends wording be added to the AC as follows:

"It is recognized that certain causes of serious injury to persons outside the aircraft cannot be mitigated by practicable changes to the type design. Examples, personnel (having disregarded cautions and warning markings/manual instructions) walking into turning propellers or being ingested,. Experience has been that many risks to persons outside the aircraft, such as the shedding of small components from the aircraft or engine, have been judged to be insignificant due to the low probability of persons being injured."

COMMENTS ON **DEFINITIONS.**

One commenter states that the proposed definition of continued airworthiness is vague and without adequate clarity to be understood by Authority or Certificate Holder. An alternative definition is proposed; "being in a state of continuous compliance with the applicable airworthiness standards appropriate to the certification basis for the product."
The Working Group concurs that the current definition does not clarify the role of continued airworthiness in relation to the product design standards. The Working Group does not agree with the definition proposed by the commenter . In some cases, the rules applying at the time of type certification were later found to be insufficient, and therefore the product may have complied with the letter of the rule while not meeting the intent. The Working Group proposes an amended definition which refers to the intent of the rule, rather than the actual rules used in the type certification basis, as follows:

> *Continued airworthiness. The ongoing activities associated with ensuring a product remains in compliance with the intent of the applicable product design standards.*

The Working Group also offers the following points for consideration on the relationship between initial certification and continued airworthiness: *It is normal and to be expected that the achieved level of safety of a product will vary throughout the lifetime of the fleet. This variation may result in some failure conditions occurring more frequently than permitted by initial certification requirements, in which case it is possible, but not necessarily the case that an unsafe condition exists. If the risk to the airplane, passengers or crew is very much greater than permitted by initial certification standards, an unsafe condition is likely to exist. In other words, there is an indeterminate area where a product no longer complies in some respects to certification standards, yet is not Unsafe. The product may, in this case, be returned to full compliance with the certification standards by normal product improvement programs, without the necessity to issue an Airworthiness Directive. Some assessment of the degree of risk is advisable if the failure condition rates significantly exceed those assumed or intended in the initial certification.*

One commenter questions the definition of "event", saying that the hazard level should be specified, since many in service events are well below the level of the CAAM guidelines.
The Working Group agrees that many of the events in service are low level. The hazard ratio is the tool for determining whether an event should be considered as potentially leading to an unsafe condition. The Working Group does not recommend a definition change in the AC as a result of this comment.

Several comments were made regarding the definition of the uncorrected event forecast, the corrected event forecast, the forecast event rate and the definition of serious injury. These comments were subsequently withdrawn by the cognizant Working Group member.

Two commenters disagree with the proposed definition of an unsafe condition; i.e., "A condition which, if not corrected, is reasonably expected to result in one or more serious injuries".
The Working Group considers the definition supports the intent that the appropriate assessment of risk is the threat to people.

One commenter proposes that "unsafe condition" be defined in FAR/JAR-1.
The Working Group notes that changes to FAR/JAR1 are outside the scope of the Working Group's task.

One commenter disagrees with the AC definition of an unsafe condition because it is not directly linked to the airworthiness standards for aeronautical products. The commenter is concerned that products might be held to a higher standard for continued airworthiness than for initial certification. The commenter states that the criteria for identification, prioritization and resolution of safety concerns should be consistent with the airworthiness standards.
The Working Group disagrees. While representing the "minimum acceptable level of safety" for certification, the certification regulations are also typically intended to provide the highest practicable standard of safety consistently attainable. Consequently, there is normally considerable margin between the standard of safety required for certification and the reduced level of safety associated with having an unsafe condition. Once the product enters service, problems may be encountered which will reduce the realized standard of safety over the short term, without an unsafe condition necessarily existing in the product. Control programs addressing these problems will, in due course, restore the product to the level of safety required for initial certification. Non-compliance with the initial airworthiness standards should not be presumed to imply that an Unsafe Condition exists. Further, unsafe conditions can be identified in service which were not adequately covered by the applicable airworthiness standards. In these instances changes to both existing airplanes and the airworthiness standards may be needed. However, the Working Group agrees that in general the continued airworthiness process should not be used to set a higher standard than that intended by initial certification.

Several commenters question the meaning of the phrase " reasonably expected" in the definition of an unsafe condition. They request clarification. One commenter questions whether the definition of "unsafe condition" addressed only severity or a combination of severity and probability.
The Working Group agrees that the term is subject to misinterpretation, and proposes that it be explicitly defined as follows:
Reasonably expected. A probability of occurrence acceptable to neither the long-term risk guidelines of this AC nor the intent of the applicable product design standards.

One commenter states that since turbofan engines have caused very few serious injuries, almost all future AD action could not be justified using this definition. The commenter cites the established FAA E&PD practice of controlling the potential for level 3 events which do not, inherently, involve injury.
The Working Group disagrees. The intent is that not only conditions which have actually caused serious injuries, but also those which are reasonably expected to do so, should be evaluated as unsafe conditions. "Reasonably expected " is defined above.

Several commenters note that the initial definition of an Unsafe condition does not appear to be maintained throughout the AC, but that broader and broader meanings of the term "unsafe condition " appeared to be used, to the point where the term becomes unbounded.
The Working Group agrees that this is a source of confusion. The intent is that the original definition of "Unsafe Condition" should be maintained throughout the AC. The Working Group recommends that elsewhere in the AC, the phrase "unsafe condition" be replaced by "potential unsafe condition" where it has not been determined that the condition is actually and in all cases Unsafe according to the definition.

COMMENTS ON **BACKGROUND.**

One commenter remembers the sequence of events differently from that stated in the background. The Working Group proposes a change in wording to accommodate different recollections regarding the CAAM committee process, as follows:

"It was decided to limit the scope of the effort to engines, propellers, and APUs installed on transport airplanes due to the availability of credible data."

One commenter requests redrafting of the following sentence, to clarify that the TAD certifies the installation but not the engine: *"Since the FAA TAD is responsible for the certification of engines, propellers and APUs as installed on transport category airplanes, identifying and responding to potential engine, propeller, or APU unsafe conditions often involves joint decision making by the two Directorates."*

The Working Group recognizes that the concept is a difficult one, but is unable to develop better wording.

Several commenters state that the listing of methods currently used to classify event severities is confusing, they appear to believe that this material offers four different approaches for use in continued airworthiness.

One commenter asks to have the methods used for initial certification removed, two commenters request that a "harmonized" common definition be developed. One commenter requests that existing (certification) methods be used so that continued airworthiness would be strongly linked to the Airworthiness Standards.

The Working Group disagrees. The listing of different methods appears in the section "Background", and offers perspective on the different approaches used to classify event severities. It is not intended that "continued airworthiness" should mean "remaining in compliance with all aspects of initial certification at all times", as has been discussed above, in the context of the definition of continued airworthiness. Initial certification is intended to mandate the highest possible safety standards for a new product; the intent of FAR 39 and this AC is to define how far, and for how long, a product may deviate from those high initial standards. It is therefore reasonable that a somewhat different approach be used for establishing event severities. The Working Group recommends that clarifying wording be added to the AC as follows: *"The reason certification classifications are not the focus of this AC is to avoid confusion as the acceptable levels of safety and risk assessment methods are different between certification and continued airworthiness."*

One commenter objects to the use of a disk burst example as an illustration of the application of Appendix 5, since a disk problem would be the province of FAA-E&PD. The commenter disagrees with the hypothetical event rate cited and the use of the term "catastrophic " when addressing an engine failure. The commenter expresses great concern over the potential for inconsistency between Directorates when addressing a given issue.

The Working Group agrees with the points made. The Working Group has developed a common process for use by both Directorates and all manufacturers, and therefore paragraph d), which is focused on the differences in event classification between Appendix 4 and Appendix 5, should be removed from the AC.

One commenter states that the flowchart does not add any value to the document . Another commenter remarks that although the AC goes into great detail on some aspects of an unsafe condition, it does not contain a concise and manageable methodology for determining when an unsafe condition exists.

The Working Group believes the flowchart is intended to perform this function. The Working Group notes that the flowchart was expressly requested by a significant portion of the prospective audience. However, the Working Group agrees that a succinct, high-level description of the process to be followed should be incorporated into the introduction. (See also General Comment 4.)

Comments to the main body of the AC

Comments to SECTION 1: ACQUIRE AND MONITOR AIRWORTHINESS INFORMATION

One commenter states that the audience for this section is not clear, since it does not reflect current business practice of manufacturers / operators working cooperatively, continually monitoring their fleets, identifying potential concerns and sharing the concerns with the authorities in both formal and informal reporting. Another commenter points out that TC holders are not obliged by regulation to perform any of the functions described in the AC, nor is it reasonable to create such an obligation without also requiring owners and operators of aeronautical products to share reports of failures, malfunctions and defects with the type certificate holder.

The Working Group agrees that the roles and responsibilities for exercising these functions are not clear. This material is intended primarily for ACO use; some steps may be performed by the manufacturer, in which case the process may vary to utilize the information/resources available. The Working Group proposes clarifying wording should be added to the AC (see general comment 1).

Two commenters question the practicability and value of monitoring component failures against the assumptions made in the initial certification analysis.

The Working Group notes that monitoring failure information, like any of the processes defined in this AC, is not mandatory. It is also noted that only a sample of failure data is likely to be available, either to the manufacturer or the FAA. However, it is likely that component failure rates which are orders of magnitude higher, or component failures with much more severe consequences, than assumed in the certification safety analysis will come to the attention of the analyst and may provide insight into the potential existence of an unsafe condition.

The following change in wording is therefore proposed to section 1:

"Monitoring the available data on failure conditions against the assumptions inherent in the original certification compliance, both for occurrence rates as well as outcome, allows for a proactive comparison of the safety-significant assumptions of certification with the actual situation in the fleet."

Comments to SECTION 2: IDENTIFY UNSAFE CONDITIONS

One commenter suggests a change in nomenclature, to distinguish between issues which may or may nor be unsafe conditions ("safety concerns") , issues which are unsafe conditions and merit an AD, and issues which were unsafe conditions but are now being controlled, by ADs, so that they are no longer unsafe.

The Working Group agrees that it is inappropriate to describe all three phases of an issue as an "unsafe condition". In response to this comment and in connection with the earlier comments on the "Definition of an unsafe condition", the Working Group recommends that this section be titled "IDENTIFY POTENTIAL UNSAFE CONDITIONS", and that all of the material in this section be reviewed, to distinguish between actual unsafe conditions and potential unsafe conditions. Specifically, sub section 2,2 should be reworded as follows:

"2. *There are at least three areas of information that can be used as a guide in identifying potential unsafe conditions. The first, and most visible, are the conditions which alone or in combination with other contributing factors have led to accidents. Such conditions or combinations have clearly been demonstrated to be unsafe. The second includes conditions that have significantly increased the probability of, but not directly caused, serious injuries. If such "contributing conditions" occur frequently enough, this too is an unsafe condition. In fact, the majority of ADs are intended to correct this type of unsafe condition. The third area of information involves hazards identified as part of the product's certification program.*"

The Working Group also agrees that once an acceptable control program has been instigated, the condition is no longer Unsafe.

One commenter questions the citation of human error as an example of an isolated event. Concern is expressed over human error which might be anticipated, as compared to gross negligence.
The Working Group considers that the example is intended to address extraordinary human error which could not be anticipated. The Working Group proposes a clarifying change in the wording, as follows:
"Recognizing the size and complexity of today's worldwide air transportation system, it would be unusual for an identified unsafe condition to be limited to a single airplane or engine. Examples of singular events where AD action would not be expected are those caused by gross negligence or a rare meteorological phenomenon."

One commenter expresses concern over the process of "assessing an unsafe condition against other products". This is felt to imply that each manufacturer would then be required to defend the reputation of each of their products with respect to an identified issue in a single product, and that this process would require disproportionate resources.
The Working Group agrees with the concern, and proposes a wording change as follows:
"Root cause problem assessments may identify concerns in other products of the same or similar type design or usage."

One commenter remarks that automated event, threshold level or trend alarms are not currently used for continued airworthiness.
The Working Group notes that these trend alarms are used by some organizations. No change is recommended.

One commenter asks that this section be removed as being redundant material.
The Working Group agrees that it is repetitive, but considers that it may be helpful to the inexperienced analyst. No change is recommended.

Several commenters note that the AC extends the scope of an unsafe condition to "conditions that can contribute to the probability of serious injuries". This would appear to promote ADs to remove all contributing conditions which could combine with an initiating malfunction to cause an injury. The commenters request guidelines or limitations on speculation as to what might contribute to an injury. The Working Group agrees, and recommends that the words "potentially unsafe condition" be used, and that phrasing be added to define the term "reasonably expected". (See comments under Definitions).

One commenter questions whether section 2,2 refers to all accidents or only to personal injury accidents.
The Working Group notes that personal injury accidents are intended, as made clear by the initial definition of unsafe condition.

One commenter points out that not all hazardous effects may qualify as an unsafe condition.
The Working Group agrees, and reiterates the recommendation that section 2,2 refer to potential unsafe conditions rather than just unsafe conditions. This will eliminate the appearance that hazards identified as part of the certification program will necessarily turn out to be unsafe conditions.

Two commenters inquire how injuries resulting from turbulence or emergency egress should be addressed, since powerplant malfunction might have initiated the situation.
The Working Group notes that the means of addressing egress injuries might be divided between the TC holder of the initially malfunctioning equipment, the TC holder responsible for egress provision and the operator practices involved. It is therefore proposed that situations involving emergency egress injuries be negotiated on a case by case basis and the AC remain silent. The Working Group recommends that the ability to discriminate between life threatening and lesser injuries be provided by the following words:

> *"The risk guidelines are intended to cover exposures to the most severe of "serious injuries" (i.e., life-threatening injuries). Consequently, relaxation of these guidelines is acceptable in cases where the associated "serious injuries" are clearly not life threatening (e.g., simple fractures)."*

One commenter requests that the wording
"*For transport category airplanes in other types of service or with unconventional design features, these conditions may still be unsafe and should be assessed on a case by case basis.*" be replaced by "*For transport category airplanes engaged in missions not intended by design.....*"
The Working Group does not agree. The proposed phrase does not reflect the intent of the AC. In order to reduce confusion, the Working Group recommends this subsection wording be changed to: "*For transport category airplanes, the FAA has defined certain specific conditions as potentially unsafe based upon previous service experience and relevant certification assessments*", dropping the second, confusing sentence.

One commenter states that the guidance on single failures in section 2,5 contradicts the definition of an unsafe condition.
The Working Group disagrees. The guidance is intended to remind the reader of certification standards, not to redefine the term "unsafe condition". However, the Working Group recommends a clarifying change in the wording as follows:
5a. Single failures. The type certification regulations limit the severity and frequency of single failures. Single failures that could result in a serious injury but are not expected to result in serious injuries to multiple persons are allowed by the regulations provided the frequency of occurrence is sufficiently low.

One commenter states that the guidance on single failures showed an unwarranted bias toward maintenance intervention, in the wording "*the results of the investigation may require AD action to implement more frequent monitoring...*" .The commenter points out the role of induced failure due to invasive on-wing inspections, and expresses concern that a forced inspection, if sufficiently frequent, might pose a greater risk of engine failure than the original subject of the AD.
The Working Group agrees, and recommends the wording be changed to "*more effective monitoring*".

One commenter states that the wording in this guidance on single failures is confusing.
The Working Group agrees and recommends the wording be changed to: *"When these failures or their precursors occur (e.g., a flaw is detected in a disk before the disk actually fails), the design of the component..."*

One commenter inquires whether an AD has ever actually been written to mandate a change in manufacturing method, as stated in the guidance.
One instance of such an AD is known to the Working Group, applied to a specific product. The Working Group agrees that referencing a change to a process is confusing and recommends deletion of the words: "*improved manufacturing methods*".

One commenter questions the realism of the statement that the installation design would be reviewed and considerations incorporated to minimize the effect of engine failures on the airplane.
The Working Group agrees that this would not be typical, and recommends the wording be changed to reflect a more general case: "*In addition, the design of the airplane is reviewed to ensure that the design covers the likelihood that these failures may continue to occur and the installation incorporates design considerations to minimize the impact of these failures on the airplane.*"

One commenter states that the material on latent failures, on cascading failures and on multiple failures deals only with certification standards and that the value of the paragraphs is not clear.
The Working Group considers that these paragraphs are intended to remind the analyst that single failures are not the only sources of unsafe conditions, and that the certification analysis may be helpful in identifying a potential unsafe condition for systems with complex architecture.

One commenter points out self-contradictory wording in the guidance on cascading failures, in that if the failure of one load path causes the failure of another, then they were not, by definition, redundant.
The Working Group agrees, and recommends the wording be changed to "*For example, in the structural design area, the failure of one load path should not result in loads that compromise the intended redundancy.*"

One commenter proposes that FAR 25.901 be cited as a source for safety assessment methods.
The Working Group disagrees, since FAR 25.901 does not contain guidance on such methods.

One commenter contends that engine overspeed is not a hazard, but that its consequences may be hazardous.
The Working Group concurs that engine overspeed is not of itself hazardous. The AC does not state that engine overspeed is hazardous, and so no change to the AC wording is recommended in this regard.

Several commenters question the appropriateness of the guidance given on In-Flight shutdowns, in the section addressing multiple failures and probability estimates. One commenter points out that there is no requirement during certification to demonstrate a low probability of multiple in-flight shutdown, and that the IFSD rate of "concern", 2E-4 IFSD/hour is well within historically acceptable norms. Another commenter points out that today's engines greatly exceed the reliability standard cited, and that therefore this guidance (of 2E-4 for an IFSD rate) is irrelevant to any realistic situation.
The Working Group notes that in the past there have been differences of opinion over whether a given IFSD rate is good, bad or the norm, and that citing a rate in this AC will be helpful in resolving such concerns. The Working Group recommends the wording be changed as follows: "*Engine shutdown rates below approximately 2E-4 failures/cycle should not be cause for concern.*"

One commenter expresses concern over the phrase " *it should be recognized that engine anomalies apparent to the crew in critical flight regimes may also lead to instances of inappropriate crew response due to increased stress and workload. Repeated exposure to these events increases the likelihood of an inappropriate response*" The commenter points out that both FAR 25 and FAR 33 assume or require that the failure of one engine in the most critical flight regime is a safe event.
The Working Group agrees with the concern. The AC is apparently attempting to address engine stall at V1, quiet autothrottle malfunctions and various other effects which have, in combination with inappropriate crew response, resulted in accidents in the past. The consistency of this wording with initial certification requirements is not clear, nor are the implications for continued airworthiness. The Working

Group recommends that if crew error is to be incorporated into the assessment of malfunctions, clear and specific guidance be given upon how to do so. The following wording change is recommended:
In addition, it should be recognized that certain engine anomalies during critical flight regimes have, on occasion, resulted in accidents due to lack of recognition or appropriate response to a single engine failure, especially in cases of very startling or very subtle failures. Excessive exposure to these events raises the possibility of an inappropriate response. Care should be taken in situations where certification assumptions of appropriate responses, and the timing of those responses, have been repeatedly called into question.

One commenter queries the definition of common mode failure, suggesting that "multiple dependent failures" is intended.
The Working Group disagrees. The intent is multiple otherwise independent failures occurring due to the same initiating event. The Working Group recommends the following clarifying change to the wording: *"multiple otherwise independent failures"*.

One commenter queries the list of environmental factors in the causes of common mode failures. The commenter suggested that corrective action properly belongs at the source of the threat rather than by design action.
The Working Group agrees that volcanic ash concern is not likely to be remedied by design change and that "volcanic ash" should be replaced by "icing". The other environmental threats cited may be a concern in the event of a design deficiency, and the concern may also lead to a change in certification standards.

One commenter expressed concern over the identification of common cause maintenance error as a common mode concern, and the ability to address this concern by a fleet action plan.
The Working Group agrees that no clear means exists to address all instances of this threat. The Working Group recommends that the wording "currently" be deleted from the sentence "*There are currently no regulations specifying that any engine-related maintenance be conducted on only one engine at a time* ..."

One commenter questions the validity of providing a list of structured methods and tools.
The Working Group recommends that the wording be changed to clarify that these tools are available, but need not always be used or usable. The Working Group recommends a wording change as follows: "tools that can aid in the process".

One commenter proposes that 25.901 be cited as well as 25.1309 in 5 d (1) of Section 2.
The Working Group agrees that 25.901 is directly applicable to propulsion systems, but it does not contain any safety assessment methods in the rule or AC. The Working Group recommends that the wording "the safety methods associated with 25.1309" is appropriate.

Comments on SECTION 3: DETERMINE APPROPRIATE RESPONSES TO IDENTIFIED UNSAFE CONDITIONS

One commenter asks for clarification of the circumstances under which the FAA would provide an exemption from the initial Basis of Certification. The commenter proposes a hypothetical situation in which only a small fleet is involved, so that the level 4 outcome is not anticipated to occur in the lifetime of the fleet (although the instantaneous probability may be higher than normally accepted). The cost of corrective action in these circumstances might not be economically reasonable.
The Working Group understands the concern, but believes that the reason for having a ceiling on the risk per flight is to protect any individual passenger from an unduly high risk. Small fleet size, therefore, does not automatically justify an exemption. However, the FAA may consider cost-benefit studies in determining the public interest.

One commenter asks for clarification of the meaning of the word "*outcomes*" in subsection 3.
The Working Group suggests that "outcomes" be replaced by "*airplane- level effects.*"

One commenter asks for clarification regarding the validation of assumptions; the commenter suggests that data gathering would be one means to do this.
The Working Group agrees that data gathering to validate assumptions would be a normal part of the process. In the interim, action might be required based on more conservative assumptions.

One commenter remarks that the focus of the process must be quantitative. The comment supports the current wording of the AC in that respect, and so the Working Group does not recommend any change.

One commenter expresses concern at many points that the AC is heavily biased towards immediate and possibly ill-considered action.
The Working Group considers that this concern has been addressed by defining the term "reasonably expected" in the definition of an "unsafe condition". The Working Group also recommends that the title of the section be changed to "Develop and implement appropriate responses"

One commenter expresses concern over the example given for immediate action (thrust reverser deployment in flight). The comment was subsequently withdrawn by the cognizant member of the Working Group.

One commenter argues that the phrase "*Unsafe conditions that are not mitigated by contributing or conditional factors may require expedient action unless the root cause, failure distribution and risk can be confidently established*" places an unreasonable burden of proof upon the analyst at a very early stage in the process.
The Working Group agrees and proposes that the word "*confidently*" be replaced by "*reasonably*".

One commenter points out that the AC is incorrect in stating in this section "*The intent of these assessments is to ensure that an unsafe condition that represents the greater risk receives higher levels of attention and resources for its timely resolution than does one that represents a lower risk*". The wording describes the intent of the whole AC, rather than this sub-element of the process.
The Working Group agrees that it would be more appropriate in this section to say "*The intent of these assessments is to establish whether an unsafe condition exists and to ensure*".
The commenter also points out that the intent of the uncorrected risk forecast is mis-stated here. The Working Group agrees, and proposes that the following words be deleted from this section. "*Additionally, the intent is that the risk associated with each unsafe condition, during the time necessary to address it, are less than the applicable risk guidelines*".

One commenter maintains that elements of step 2 (Estimate the uncorrected event forecast) and 3 (Determine whether immediate action is necessary) duplicate each other, in the discussion of hazard ratios.
The Working Group agrees. The material on hazard ratios should be removed from paragraph 2, which was intended to address events, as opposed to the bottom line risk. The Working Group recommends a review of the whole AC for clarification and streamlining.

One commenter disagrees with the guidance regarding comparison of risks, since the risks should be compared to an objective standard.
The Working Group agrees, but acknowledges the need of the FAA to compare risks in order to prioritize activity. The Working Group therefore proposes the addition of wording as follows: "*Whatever exposure basis is used (flights or hours) it should be used consistently to allow the various risks being managed simultaneously to be compared to each other and the risk guidelines.*"

One commenter expresses concern that hazard ratios not be used inappropriately. One commenter requested that more specific material be provided on the development of hazard ratios.
The Working Group agrees, and proposes the following wording for incorporation into the AC:
"***HAZARD RATIO DEVELOPMENT.*** *Developing a hazard ratio will require considerable engineering judgment. The hazard ratio strongly influences the quantitative assessment results and, therefore, should have a sufficient validation basis or be assessed conservatively. Hazard levels are used for CAAM levels 3, 4 and/or 5, as is appropriate to establish the appropriate comparison of the risk of the unsafe condition to the CAAM guidelines.*

The following methods should be employed to establish the hazard ratio for a given CAAM level (X):

a. At least one level X or higher event has occurred.

1. Data. When at least one level X or higher event has occurred, use the value obtained by dividing the number of level X or higher events by the total number of events . If the latest event used in the calculation was not level X or higher, add one additional level X event, and one additional event to the totals (e.g., 1:4 becomes 2:5). The addition of another event is to provide an element of conservatism for the true value of the hazard ratio as estimated by the data to date. Alternatively, use the ratio obtained by counting only the events up to and including the most-recent level X event. This alternative should be used if the ratio of the number of level X events divided by the total number of events at the time when the last level X event occurred is lower than the ratio when one more level X event is assumed. For example, a history of 6 events, in the sequence 0 0 X 0 0 0, would result in a level X hazard ratio of 1:3 at the time the last level X occurred as opposed to assuming an additional event for a hazard ratio of 2:7.

2. Analysis. If analysis suggests the true hazard ratio, that ratio may be used. For example - for a particular airplane, a propeller blade will pass through the fuselage if it is released within a 90° arc. The hazard ratio (assuming level 4 for serious injury to passengers seated in the plane of the propeller) would then be 90°/360°=0.25 level 4 events given a blade release. This method has particular value where little data exists. Note: when the hazard ratio obtained by analysis is significantly different than what would be calculated from the observed data, it is strongly suggested that the observed data be used to establish the hazard ratio.

b. No level X or higher events have occurred.

1. Historical data. The Technical Report on Propulsion System and APU-Related Aircraft Safety Hazards provides hazard ratios for level 3 and 4 events. These historical hazard ratios should be used cautiously. The hazard ratio is installation dependent, and the historical hazard ratio may be skewed by the historical data available for the affected aircraft installation. Reading the summaries of the events from which the hazard ratios were developed will provide valuable insight into the applicability of the data. Some examples of the installation dependency of the hazard ratio are supplied here for illustration:

i. Engine separation. There are a large number of examples of engine separation in flight on older aircraft without adverse effects upon airplane control. More recent designs of aircraft, although designed with the same intent of allowing safe separation, have encountered difficulties after the separation of high bypass ratio engines. Separation of a wing-mounted engine may have very different consequences than separation of a tail-mounted engine.

ii. Uncontained rotor. The potential effect of an uncontained rotor depends largely upon the airplane systems in the plane of the rotor and their proximity to the engines. The effects may be very different for a wing-mounted installation and a fuselage-mounted installation.

2. Next event assumption. Where no level X or higher event has occurred, and no industry-wide data are available or suitable, a conservative hazard ratio may be established by assuming

the next event would be level X or higher (e.g., 0:4 becomes 1:5). There may be cases where this method is overly conservative.

3. Analysis. As described above, engineering analysis may allow for accurate estimation of the hazard ratio.

Communication between the engine/propeller/APU manufacturer, installer, operators and the FAA is often necessary, especially if no appropriate historical hazard ratio is available. Additionally, it may be necessary to use engineering judgment to assess the impact of unique features of a specific powerplant or APU installation.

One commenter inquires whether step 5 (Estimate effects of candidate actions) should refer to injuries.
The Working Group agrees that the wording should be changed to: "*This is to consider their capacity to reduce the future risks to acceptable levels*".
The same commenter also remarks that the description of this step does not follow current business practice, in which the OEM will propose the candidate actions based upon data and FAA/operator input, with an assessment of risk reduction, to the FAA.
The Working Group disagrees; the AC does not specify who proposes the candidate actions and it is anticipated that the OEMs, FAA and operators will all cooperate in such an evaluation.

One commenter requests that the word "money" be removed from step 5b, due to legal sensitivities. The commenter also requests rephrasing to clarify that conducting a risk assessment is the expected norm.
The Working Group agrees, and proposes that the paragraph be reworded as follows: "*Resources are generally considered to be time, material (parts and inspection equipment), and labor. However, there are additional considerations such as shop capacity, parts distribution issues, operational disruptions and lost revenue. The extent of these required resources should be estimated to quantify the impact of the AD or other corrective action, such as improved training and interim non-AD actions, allow for timely provisioning, and aid in the determination of desirable tradeoffs between resources and risk. Depending on the analysis that has been performed, the number of replacement parts, shop visits, inspections, etc., may be available as output parameters. However, the results from the steps used to establish risk can likewise be used to estimate impact on resources. Data will often be required from the manufacturer(s), operators or both to aid in this process.*"

One commenter requests that "*replacement parts availability*" be explicitly listed as a consideration of resource requirements.
The Working Group considers that the concept is included in the term "*parts distribution*"

One commenter supports the AC guidance "*Prohibition of airplane operation based on an observed unsafe condition, pending determination of the root cause and appropriate corrective action, is typically an unnecessary level of conservatism.*" and asks that it be made stronger, since grounding airplanes is rarely appropriate or desired.
The Working Group agrees, and recommends the wording be changed to "*Prohibition of airplane operation based on an observed unsafe condition, pending determination of the root cause and appropriate corrective action, is rarely necessary...*"

The AC currently states; "*If a decision is made to not implement a candidate corrective action, the decision and its justification should be documented and filed for future reference.*" One commenter asks for clarification on the circumstances for which no corrective action would be taken for an unsafe condition.

The Working Group recommends a clarification to the wording as follows: "*If the FAA decides not to implement a particular candidate corrective action...*"

One commenter proposes that paragraphs d(1), d(2) and e should be replaced with two sentences: "*The process and results from the implementation of the corrective action plan should be monitored to ensure if it is effective. If the plan is not achieving acceptable results, then the plan should be modified to correct the deficiency*"
The Working Group considers that the current wording gives more detailed guidance, and should be retained.

One commenter suggests that the wording "*The FAA response to an unsafe condition should be based on a technical understanding of the problem and should require an appropriate implementation schedule ...*" have the word "*should*" replaced by "*will*".
The Working Group does not agree. The word "will" describes the optimum situation, but in some special circumstances, variation from the optimum will be unavoidable.

Two commenters raise concerns over the guidance on cumulative risk. They point out that there are no standards for an acceptable level of cumulative risk, that there would be difficulties in calculating such a parameter and that data does not support the contention that cumulative risk is an issue. One commenter asks whether the risk is to be assumed to accumulate through consecutive programs, and maintains that this approach would be statistically invalid.
The Working Group agrees that clarification is needed. The AC does not intend to suggest that consecutive programs increase risk, but to address the situation with many concurrent control programs. The Working Group proposes wording be added as follows: "*It is neither expected nor required to calculate cumulative risk nor track cumulative risk across the life of the fleet. The intent of this paragraph is only to provide recognition that acceptable risk levels should be regarded as upper limits*".

Several commenters request that section 3 be streamlined and clarified since it is currently very confusing.
The Working Group agrees, and recommends that this be done for the whole AC.

Comments on SECTION 4: LESSONS LEARNED.

One commenter states that the role of the manufacturers is not recognized in this section, and that it should be re-drafted.
The Working Group agrees that this section is written only from the FAA perspective, and proposes wording as follows: "*Centralized accessible repositories for CAAM "lessons learned" (e.g., risk models, hazard ratios, AD worksheets, etc.) are a valuable resource. As such centralized data repositories become available for general use, reference to these resources will be included in future revisions of this AC*".

One commenter suggests that additional material be included, as follows: "*Given that an unsafe condition is determined to exist, which is not adequately addressed by current Airworthiness Standards, an Airworthiness Directive will be issued and rulemaking action will be undertaken. In the interim, generic special conditions should be developed and imposed until such time as the new rulemaking actions are completed.*"
The Working Group agrees, and proposes this material be incorporated into the AC.

COMMENTS ON SECTION 5: ALTERNATIVE METHODS OF COMPLIANCE (AMOC)

One commenter asks for clarification of the term "*an equivalent level of safety*", including a formal definition and examples.
The Working Group notes that this term is widely used outside this AC and therefore feels it would be inappropriate to provide a definition which might then conflict with other equally valid usage.

One commenter questions the guidance on AMOCs. The comment was subsequently withdrawn by the cognizant member of the Working Group.

Comments on APPENDIX 1: HISTORICALLY UNSAFE CONDITIONS

Many commenters are concerned that the list of conditions in Appendix 1 appears to greatly expand the definition of an unsafe condition, effectively placing no bounds on what can be considered unsafe. Some of the examples are noted as being, in today's operating environment, much less unsafe than others. Concern is expressed that publication of such a list, without the accompanying hazard ratios, might be misleading; it is recommended by several commenters that the hazard ratios be developed and published with the list of conditions.
The Working Group agrees with the concern expressed. The Working Group recommends that the entire Appendix be removed from the AC. The Working Group recommends that an AIA/AECMA study group be tasked with collection of data to update the original CAAM data and also to develop hazard ratios for each condition cited in Appendix 1. The Working Group proposes that Appendix 1, with hazard ratios, be part of the report published by this AIA/AECMA group. The Working Group also recommends that Appendix 1 refer to a *potential* unsafe condition throughout.
If an updated CAAM report incorporating the Appendix 1 material is not available for reference by the time the AC is to be released, the Working Group recognizes that the FAA will proceed with inclusion of the best available information as Appendix 1.

Comments on APPENDIX 2: AIRWORTHINESS INFORMATION RESOURCES

One commenter explains that Appendix 2 does not reflect the business practice of OEMs, who may have much more detailed and accurate information relating to their own products than can be found in the cited databases. The commenter proposes that this appendix be removed.
The Working Group agrees that manufacturers may have other information, and recommends the following change: " ***PURPOSE***. *This Appendix provides a brief description of some airworthiness information resources that may be of use in supporting continued airworthiness assessments. More complete data may be available from the manufacturer.*"

Comments on APPENDIX 3: STRUCTURED ASSESSMENT METHODS AND TOOLS
One commenter is concerned that the material printed is too basic, to the point that anyone who needed this appendix would lack the necessary background to perform a risk analysis.
The Working Group notes that this AC is intended for a broad audience, and that much of the material will already be understood by an experienced analyst (see the note to this effect in the introduction).

One commenter requests that SAE ARP 5150 be cited in this appendix.
Since ARP 5150 is not yet published, the Working Group felt unable to evaluate its appropriateness. It is recommended that the citation of ARP 5150 be reconsidered once it is published in final form.

Comments on APPENDIX 4: ADDITIONAL ENGINE AND PROPELLER DIRECTORATE (E&PD) GUIDANCE

As stated in the general comments, the Working Group recommends that Appendix 4 be relocated to the main body of the AC, as explained in Attachment 1. Specific comments to the wording of Appendix 4 are, nevertheless, dispositioned here.

One commenter supports the guidance that the installer should be involved when assessing the hazard ratio (paragraph 6b) and asked that this guidance appear in the main AC.
The Working Group notes that similar guidance already appears in section 3.1(a)2.

One commenter asks for guidance on the calculation of flight exposure.
The Working Group agrees that clarification is required. The Working Group considers that the term "flight exposure" is intended to mean the number of flights that the fleet under assessment will accumulate in a given configuration. If the risk is reduced or eliminated from some part of the fleet, the flight exposure is reduced accordingly.

One commenter proposes that technical judgment play a major part in calculating hazard ratios.
The Working Group has prepared additional material on the calculation of hazard ratios.

One commenter questions the use of the wording " *Cumulative risk*" in section 8.
The Working Group agrees that this phrase should be replaced by "*aggregate risk*".

One commenter remarks, in the discussion of "reasonable risk", that the discussion of the relationship between CAAM levels and certification guidelines is technically incorrect.
The Working Group agrees and recommends that this material be removed. The Working Group also recommends a clarifying change to wording as follows: "*Event forecasts of 1.0 level 3 events in 100 million aircraft flights ($1x10^{-8}$) meet the long term acceptable risk target for part 33*".

One commenter asks for clarification of the sentence in section 9 "*These event guidelines should not be regarded as targets or typical values*".
The Working Group notes that it is explained earlier in the AC that the guidelines represent an upper boundary, and that it is not anticipated or desired that control programs will remain at the upper boundary.

One commenter is concerned about the guidance that "*critical failure modes should be managed to much lower level 4 event forecasts (risk factors) to minimize the cumulative effects of multiple unsafe conditions*" in that this does not provide a clear pass-fail criterion.
The Working Group agrees that each case is up to the discretion of the administrator, as explicitly stated in the introductory material.

One commenter requests that operators be involved early in the process of developing a model and Hazard Ratios.

The Working Group recognizes the concern of operators that they may be negatively impacted by a process into which they had no input. The Working Group recommends section 6 incorporate the following wording: "*agreement by consensus on critical assessment model inputs is essential, including validation of operational data by operators.*"

The Working Group also recommends the following wording be used in section 7: "*Communication between the engine/propeller/APU manufacturer, installer, operators and the FAA to determine the event hazard ratio assessment is necessary if no appropriate historical hazard ratio is available*".

Comments on APPENDIX 5 ADDITIONAL TRANSPORT AIRPLANE DIRECTORATE (TAD) GUIDANCE

As stated in the general comments, the Working Group recommends that Appendix 5 be removed from the main body of the AC, as explained in Attachment 1. The concerns expressed are, nevertheless, given here.

In addition to the concerns addressed earlier regarding different guidance between Directorates, many commenters believe that the approach proposed in Appendix 5, of forecasting the number of expected injuries, is completely unacceptable to industry. Commenters point out that this is unprecedented in current airworthiness standards and is equivalent to new rulemaking. Many commenters believe that this would lead to great difficulties in product liability lawsuits, that the FAA cannot protect this information under FOIA, and that OEMs do not enjoy the same immunity in this respect that Government bodies do. The FAA representatives to the Working Group did not have the same visibility of the concern.

The Working Group agrees with these concerns. The Working Group notes that FAA-TAD wishes to be able to distinguish between unsafe conditions involving local risks, involving a few passengers, and unsafe conditions involving whole-airplane risks. The Working Group has developed an approach which will accommodate the needs of industry and of both FAA-Directorates (see Attachment 1).

Detailed comments on Appendix 5 are also addressed below. Although it is recommended that appendix 5 be removed from the AC, these detailed comments and dispositions are recorded for historical completeness.

One commenter disagreed with the use of the example of a disk uncontainment in Appendix 5, since a disk problem would be addressed by E&PD. The Working Group disagrees. Although disk uncontainment would typically be addressed by corrective action to the engine, it might also involve corrective action at the airplane level if a design deficiency in mitigating the risk of an uncontained rotor were identified.

While the FAA Transport Airplane Directorate would prefer to retain the Appendix 5 approach in the AC, in consideration of the concerns of the majority and the recognition that (as with the proposed "Level 5") more experience with the expanded CAAM is needed to assure valid and effective Appendix 5 guidelines are established, they will agree to remove Appendix 5 provided:

1) a common event based assessment process, including a new Level 5, can be agreed and added to the main body as recommended by CAA Working Group;
2) the commitment to: 'develop valid and effective Level 5 event guidelines' is noted in the AC; and
3) an additional step is included in the common process which recognizes that: 'The FAA Transport Airplane Directorate will take the assessment one step beyond "event forecasts" and consider the number of persons expected to be seriously injured per event as required to allocate necessarily limited resources and determine what regulatory actions are justified.'

The Working Group notes that removing Appendix 5 from the AC and replacing it with the above reference to the associated considerations does not preclude the FAA Transport Airplane Directorate from further refinement and utilization of an Appendix 5 type process and guidelines for its internal use and standardization.

One commenter remarks on inconsistency between the results of using the level 4 risk boundary vs. the injury risk level boundary. The commenter requests that the acceptable risk levels be consistent with the percentage of level 4 events that result in serious injury.
The Working Group agrees that there is inconsistency. The Working Group considers that there is not necessarily a linear mapping between the guidelines for level 4 events and injuries. The Working Group proposes a methodology which uses a common process and will make this concern moot.

One commenter takes issue with the wording : "*Note that not all persons exposed to serious injury may be seriously injured* " The commenter states that this is both incorrect and inconsistent with the earlier text, since for a catastrophic condition, all exposed passengers will suffer the full effects of the event.
The Working Group disagrees. The historical record shows that accidents involving serious injuries do not always injure every individual on board. The Working Group agrees the wording appears to cause confusion.

One commenter disagrees with the value of 80% for the percentage of uncontained rotor failures which do not result in serious injuries and 20% resulting in serious injuries
The Working Group agrees numbers should be validated as a general principle. It is recommended the examples be reworked; a value of 90% is a non-specific generic number (based on SAE Uncontained reports).

One commenter alleged that the calculation of expected injuries would be difficult to substantiate. The comment was subsequently withdrawn by the cognizant member of the Working Group.

One commenter asks for clarification on the assumptions regarding load factor. The commenter questions the cited value of 90%, and inquires whether operators with higher load factors will be required to undergo more stringent corrective actions. The commenter also inquires whether cargo operators will therefore be allowed very lenient corrective action plans.
The Working Group agrees that a 70% load factor is more representative, and recommends the wording be changed accordingly. The Working Group interprets the AC as calculating risk values on a fleet-wide basis, rather than operator by operator; an operator with high load factors would not be required to have a more stringent corrective action plan. The Working Group recognizes that where resources are limited, priority is given to passenger aircraft types over cargo aircraft.

One commenter claims that the injury exposure calculations are too subjective and cannot be substantiated.
The Working Group disagrees. TAD considers that they have the appropriate information to generate these calculations. There is no expectation that others (OEMs, operators or FAA E&PD) would perform such calculations.

One commenter questions the mathematical process used to develop the injury exposure risk (use of a scalar factor), on the grounds that the calculations should not be adjusted to justify past agency actions.
The Working Group disagrees. Past TAD actions are not in dispute; it is reasonable when developing a new process to verify that it gives similar results to an existing, acceptable process. This may be considered as calibrating the mathematical model to good historical practice.

One commenter questions whether the examples were legitimate, whether failures actually exist which will always lead to a fuel tank explosion, and whether engine failures exist which will always lead to the injury of a single passenger.
The Working Group understands that there are actual failures which would always produce a fuel tank explosion. There are airplane systems which can only lead to injury of a single individual. The example is intended to illustrate the range of severities which may be considered, examples exist at each end of the range. The Working Group does not recommend a change to the AC wording.

One commenter inquires about the distinction between events which produce fatal injuries and those which produce fatalities, pointing out that the manufacturer will find it hard to discriminate between the two, since an element of chance determines the severity of the injury.
The Working Group agrees that events which seriously injure are similar to those which produce fatalities. The process outlined in the AC does not rely on a distinction between serious injury and fatality; serious injuries are considered to encompass fatalities.

COMMENTS ON APPENDIX 6: ASSESSMENT EXAMPLES
One commenter requests that the examples of calculating number of passenger injuries be removed.
The Working Group agrees, since this methodology is not anticipated to appear in the final AC.

One commenter requested that the examples be made more generic/less recognizable. The comment was subsequently withdrawn by the cognizant Working Group member.

One commenter posed many questions regarding the use of the compressor disk fracture example, inquiring why coordination with the airplane manufacturer and TAD might be necessary. The comments were subsequently withdrawn by the cognizant Working Group member.

Attachment 1: Common process for use by E&PD and TAD.

The Working Group proposes that E&PD and TAD use a common process, and that this should be based upon the material given in Appendix 4.
The Working Group acknowledges that TAD wishes to prioritize potential Unsafe Conditions into more discrete graduations of risk than sustained by the CAAM process, which defines risk levels 0 to 4. Since TAD may have hundreds of potential unsafe conditions to address on a single airplane model in one year, it wishes to assign graduations of risk within the CAAM level 4, so that its activities may focus on the most severe "level 4s" as a highest priority. The mechanism which TAD has proposed for this prioritization is calculation of the expected number of injuries for a given potential Unsafe Condition. The Working Group proposes that CAAM level 4 be split into two levels, a level 4 and a level 5, and that this will provide TAD with the desired ability to prioritize.

It is proposed by the Working Group that the new level 4 and 5 be defined as follows:
Level 4
4a. Serious injuries (Evacuation injuries excluded)
4b. Forced landing without serious injuries.

Level 5
Catastrophic outcome (ref Catastrophe as defined by AC 25.1309-B)

It was considered appropriate to remove hull loss from level 4, since it was felt that it represented an outcome less directly related to safety; this issue may require further exploration during the update to the CAAM database. A comment from a Working Group member regarding this recommendation was received after completion of the Working Group activity; this comment was not discussed by the Working Group but is given here without a Working Group disposition: "It was considered appropriate to remove hull loss from level 4, since it was felt that it represented an outcome less directly related to safety. One WG member disagrees with this view and this issue may require further exploration during the update to the CAAM database."

It is proposed that the acceptable risk upper boundaries for the new "level 4" events remain as in Appendix 4. It is also proposed that no upper boundaries be defined as yet for the new "level 5" events, since the industry and FAA lack experience in quantifying risks for this type of control program (the majority of risk calculation so far has been performed by Engine Manufacturers and the E&PD, who have very few potential Unsafe Conditions which might result in a level 5 event). The Working Group recommends that upper boundaries be developed for level 5 event risks as soon as is practicable, and incorporated into the AC. The Working Group also recommends that wording to this effect be incorporated into the AC.

It should be noted also that industry members that have worked with the CAAM levels 1 to 4 for many years have found that these levels are sufficient for their needs. When a safety concern with the potential to result in a level 4 event is identified, resolution of that concern is immediately assigned the highest priority. Corrective action is typically limited by the physical resources available such as the parts or inspection tooling which are available or can be made available within a reasonable time span. Since a potential level 4 already receives such prompt and vigorous corrective action, it may not be practicable to institute control programs which are more aggressive than those already existing for level 4.

The Working Group proposes that Appendix 4 (amended to incorporate level 5) be relocated into the main body of the AC. The Working Group proposes that appendix 5 be removed from the AC, since many comments were received expressing concern over the publication of the "injury count" methodology (see main report for detailed comments). In order to address the need of TAD to prioritize programs, the Working Group proposes that the AC incorporate wording to make it clear that TAD can and will use this injury count approach internally, as needed. The proposed wording is as follows: "The FAA Transport Airplane Directorate may take the assessment one step further and consider the number of persons expected to be seriously injured in an event when allocating necessarily limited resources and determining what regulatory actions are justified."

It should be noted that considerable discussion was required to develop the above recommendations. The Working Group considers it useful that the main points of discussion be recorded, to facilitate understanding of the consensus finally achieved. The main points are provided below.

Need to prioritize

Engine industry members have worked with the CAAM process for many years, and found that CAAM levels 1 – 4 provide sufficient discrimination to prioritize and manage control programs. There are comparatively few control programs controlling the risk of a level 4 outcome; most are directed towards issues which could result in a level 3 event. The TAD is faced with a different challenge, since they must write ADs against hundreds of issues a year on a single airplane model. They need to be able to discriminate between level 4s of different severities. The "injury count" approach of Appendix 5 was developed to provide a numerical continuum of severities and to enable rapid prioritization. The Working Group proposed that rather than a continuum, level 4 be separated into two levels, of different severity (levels 4 and 5). A review of the propulsion-related accident data (numbers of serious injuries per accident) for transport category aircraft supported the concept that two discrete levels were appropriate as a classification approach.

While the FAA Transport Airplane Directorate would prefer to retain the Appendix 5 approach in the AC, in consideration of the concerns of the majority and the recognition that (as with the proposed "Level 5") more experience with the expanded CAAM is needed to assure valid and effective Appendix 5 guidelines are established, they agreed to remove Appendix 5 provided:

4) a common event based assessment process, including a new Level 5, can be agreed and added to the main body as recommended by CAAWG;

5) the commitment to: 'develop valid and effective Level 5 event guidelines' is noted in the AC; and

6) an additional step is included in the common process which recognizes that: 'The FAA Transport Airplane Directorate will take the assessment one step beyond "event forecasts" and consider the number of persons expected to be seriously injured per event as required to allocate necessarily limited resources and determine what regulatory actions are justified.'

This agreement proved acceptable to the Working Group as a whole.

Precedent, custom and practice

Concern was expressed by OEMs that the methodology outlined in Appendix 5 has no precedent under current custom or practice and that no such requirement to make specific quantitative estimates of persons likely to be seriously injured exists under the applicable Airworthiness Standards for aeronautical products. Furthermore, it was pointed out that the philosophy advocated in Appendix 5, that resources are allocated according to the number of persons likely to be killed or seriously injured, rather than on the likelihood of such injuries regardless of the number, does not reflect current practice in the industry. Current practice among OEMs is to prevent accidents, rather than minimize the number of injuries. There

was great concern expressed over this policy being advocated in the public domain. It was acknowledged that TAD standard practice includes a cost-benefit analysis which may include calculations of expected numbers of injuries; this does not present a problem provided industry does not perform such calculations or use their results.

The position of the FAA Transport Airplane Directorate is that they traditionally have, currently do and intend to continue to consider the number of persons expected to be injured in an event when allocating necessarily limited resources and determine what regulatory actions are justified. This activity is considered to be consistent with all applicable U.S. laws and standards regulating rulemaking. The following is part of the "Regulatory Evaluation" boilerplate for all FAA Rulemaking: *"Executive Order 12866, Regulatory Planning and Review, directs the FAA to assess both the costs and benefits of a regulatory change. We are not allowed to propose or adopt a regulation unless we make a reasoned determination that the benefits of the intended regulation justify the costs."* This order also directs that in choosing among alternative regulatory approaches, agencies should select those approaches that maximize benefits. These costs and benefits are those to the public. TAD interpretation is that the costs and benefits are a direct function of the number of persons exposed to/protected from serious/fatal injuries by the regulatory change; an alternative interpretation might define the benefit as "preventing injury" without specifying the number of injuries – the difference is purely interpretive.

It was also pointed out that both the current AC25-1309-1A and the ARAC recommended AC25.1309-1B provide a precedent by allowing a greater probability of a failure condition considered "unsafe" by AC39-xx if the serious or fatal injures are limited to only "a relatively small number of persons other than the flight crew". This policy has been in the public domain for years and is an integral part of industry "initial airworthiness" practice.

Difficulty of estimating number of injuries

It was argued that it would not be possible to make estimates of the number of serious injuries to any degree of accuracy, consistency or repeatability. However, the member representing TAD, which has performed such estimates in the past, pointed out that once the probability of a level 4 or level 5 event was calculated, the only additional information required for such an estimate would be airplane capacity and load factor data. This is typically more readily available and analytically simpler to apply than the data and techniques required to produce the event forecasts in the first place.

Public perception

Concern was expressed that advocacy in the public domain of a methodology which implies that resources are allocated according to the number of persons likely to be killed or seriously injured, rather than on the likelihood of such injuries regardless of the number, could undermine the confidence of the flying public. It was pointed out that published "Regulatory Evaluations" may already include a formal numerical cost/benefit analysis wherein the standardized values prescribed for each injury or fatality avoided/allowed by the proposed rule change are summed and compared with the economic impacts of the rule change. The public does not appear to have difficulty with these regulatory evaluations.

Litigation exposure

Although TAD has traditionally performed estimates of numbers of injuries as part of cost-benefit analysis, this practice is not standardized across Directorates and it is not used by the industry. Concern was expressed that such calculations would have significant negative implications related to potential future litigation and the rights of plaintiffs under discovery procedures (as has been evidenced in other industries). It is noted that the FAA as a government agency enjoys special legal protection not shared by OEMs. It was suggested at one point that words could be added to Appendix 5 which would either absolve industry of any obligation to make such estimates or of any liability resulting from such estimates. Legal advice subsequently indicated that this is not possible.

There was general consensus that the FAA should not require industry to be exposed to unnecessary liability, and that the FAA should be able to follow its current practices internally without causing any problems. It was agreed that the formal numerical assessment called for within Appendix 5 should be removed, if it were replaced by an additional step within the main body which recognized that: "The FAA Transport Airplane Directorate may take the assessment one step further and consider the number of persons expected to be seriously injured in an event when allocating necessarily limited resources and determining what regulatory actions are justified." It was noted that removing Appendix 5 from the AC and replacing it with the above reference to the associated considerations does not preclude the FAA Transport Airplane Directorate from further refinement and utilization of an Appendix 5 type process and guidelines for their internal use and standardization.

Common safety across all models

A fundamental difference in philosophy was identified, which could not be resolved within the Working Group. The majority of the Working Group held that passengers flying in aircraft certified to a specific set of Airworthiness Standards (in this case CFR Parts 25 and 33) should expect to be afforded the same level of safety. For instance passengers in a Regional Jet would expect the same level of safety as passengers in a large transport aircraft. It was noted that the Directorates appear to be operating under different ground rules in this respect. It is the historical practice of TAD to prioritize resources based on the number of potential injuries, in other words, to hold large transport aircraft to a higher safety standard than commuter aircraft. This is considered to be consistent with historical AD practices for transport category airplanes and with their interpretation of the intent of Executive Order (E.O.) 12866, Regulatory Planning and Review (58 FR 51735, October 4, 1993) and DOT Order 2100.5, Policies and Procedures for Simplification, Analysis and Review of Regulations (May 22,1980).

Limited audience

The intended audience for the AC is the industry, the FAA E&PD and the FAA TAD. It was disclosed early in the discussions that no industry member intended to use the process outlined in Appendix 5, nor did the E&PD. It was then suggested that publication in an AC of guidance intended solely for internal use by one Directorate would be inappropriate. However, it was also argued that since the Transport Airplane Directorate makes the continued airworthiness decisions for transport category airplanes, it would be appropriate for the AC to accurately reflect all the technical considerations which go into those decisions. It was suggested that publication of Appendix 5 would provide useful visibility of the TAD decision process.

1) Publication of the Federal Register Notice: Include date of publication. The announcement of task commences establishing the Working Group. Reference: Paragraph IV.B.(3)

2) Work Plan Approval: The work plan defines the task assignment, identifies the issues to be resolved, identifies individual assignments, develops a schedule, and establishes common ground rules by which the group will function. The work plan is developed and agreed upon by the HWG and must be approved by TAEIG. As the FAA Representative is a member of the HWG, the work plan should receive acceptance by FAA Legal. The legal review is primarily to determine workload and scheduling. Reference: Paragraph IV.C.

3) Concept Approval: The Concept is intended to provide a detailed discussion of the proposed recommendation and may include proposed regulatory language. FAA Legal review of the concept must occur prior to HWG approval of the concept. The FAA Legal review of the Concept is a cursory review of the HWG proposal and draft regulatory language. The working group presents the Concept to TAEIG for approval. The presentation of the Concept should be included in the agenda set forth in the *Federal Register* announcing the public meeting. When the Concept is approved by TAEIG, it will serve as the detailed outline for the proposed rulemaking document. Reference: Paragraph IV.D

4) Preliminary Tech Writer and Legal Support: After ARAC approves the Concept, the HWG may proceed with developing the actual recommendation document. The FAA can provide support to draft the working group's document to ensure that the recommendation is properly written, is in the required format complying with legal requirements, and is fully justified. If this support is not requested, a Final Draft submitted to the FAA is subject to change upon Formal Tech Writer and Legal review. Tech Writer review needs to occur prior to the Legal review. Preliminary reviews can be performed multiple times with the end goal of creating an ARAC package recommendation that meets all technical writing and legal requirements. To obtain FAA drafting support, the HWG Chair notifies the ARAC Assistant Executive Director, who in turn notifies the Office of Rulemaking or the Directorate writer/editor manager. Reference: Paragraph IV.E.(5)

5) Technical Approval in HWG: After the documents are drafted, the HWG must approve this final draft. Technical approval must include completion of the Preliminary Legal and Tech Writer support. FAA team and HWG approval must be included in the Technical Agreement. TAEIG must approve the package before submitting to FAA for Formal review. This constitutes "Technical Agreement" for purposes of the TAEIG work plan that was laid out in Dec 1997. Reference: Paragraph IV.E.(6)

6) and 7) Economic Evaluation and Formal T/W and Legal Review: After regulatory language and preamble material have been drafted, economist support and FAA Formal Legal review are requested. When TAEIG submits a package for Formal Review, the FAA economist performs an evaluation. Following completion of the economic evaluation, the FAA Tech Writers and Legal will make a last review for any possible changes due to the regulatory evaluation by the economist. Reference: Paragraph IV.E.(7) and (8)

8) Technical Agreement: When drafting of the final package is complete, including the preamble material, economic evaluation summary, regulatory language, and the full economic evaluation, the HWG should reach technical agreement on the completed package. This package will be the document that the HWG wants to submit to TAEIG for recommendation to the FAA. Technical Agreement is complete upon TAEIG approval. Reference: Paragraph IV.E.(9)

9) Recommendation to the FAA: TAEIG must approve the package submitted by the HWG, and submit to the FAA with a cover letter. The working group presents the recommended package to TAEIG for approval. The presentation of the recommendation should be included in the agenda set forth in the *Federal Register* announcing the public meeting. Reference: Paragraph IV.E.(10)

Note: All references refer to "Operating Procedures for the Aviation Rulemaking Advisory Committee (ARAC)" [Green Book] as revised 10/97.